

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
11 April 2002 (11.04.2002)

PCT

(10) International Publication Number  
WO 02/29284 A1

(51) International Patent Classification<sup>7</sup>: F16H 25/20,  
H02K 7/06

(21) International Application Number: PCT/DK01/00644

(22) International Filing Date: 3 October 2001 (03.10.2001)

(25) Filing Language: Danish

(26) Publication Language: English

(30) Priority Data:  
PA 2000 01466 3 October 2000 (03.10.2000) DK

(71) Applicant (for all designated States except US): LINAK  
A/S [DK/DK]; Smedevæget 8, Guderup, DK-6430 Nord-  
borg (DK).

(72) Inventor; and

(75) Inventor/Applicant (for US only): NIELSEN, Jens, Jør-  
gen [DK/DK]; Brombjerg 6, DK-6310 Broager (DK).

(81) Designated States (national): AE, AG, AL, AM, AT, AT  
(utility model), AU, AZ, BA, BB, BG, BR, BY, BZ, CA,

CH, CN, CO, CR, CU, CZ, CZ (utility model), DE, DE  
(utility model), DK, DK (utility model), DM, DZ, EC, EE,  
EE (utility model), ES, FI, FI (utility model), GB, GD, GE,  
GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ,  
LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN,  
MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI,  
SK, SK (utility model), SL, TJ, TM, TR, TT, TZ, UA, UG,  
US, UZ, VN, YU, ZA, ZW.

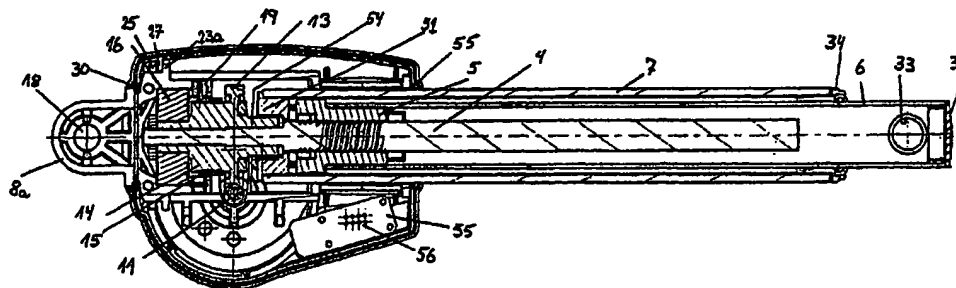
(84) Designated States (regional): ARIPO patent (GH, GM,  
KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian  
patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European  
patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE,  
IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF,  
CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD,  
TG).

Published:

— with international search report

For two-letter codes and other abbreviations, refer to the "Guid-  
ance Notes on Codes and Abbreviations" appearing at the begin-  
ning of each regular issue of the PCT Gazette.

(54) Title: A LINEAR ACTUATOR



(57) Abstract: A linear actuator, e.g. used for adjusting furniture, and of the type comprising a housing (1) with a reversible electric-motor (2) which via a transmission (11, 13) drives a spindle (4) with a force absorbing bearing (16). On the spindle there is a nut (5), to which an actuation rod (86) is fixed surrounded by an outer tube (7). The actuator is with the actuation rod and a rear mounting mounted in the construction into which the actuator should be built-in. The motor housing is part of the supporting construction, as a console is fixed to this (10) with a fixing for the outer tube, spindle bearing and a rear mounting and is designed to absorb the forces occurring hereon. This provides the possibility of cost optimizing of the actuator. As the housing, as with previously known actuators, need not to absorb and transfer forces, this can be made as a thin shell. Also there is a basis for reducing the manual assembly.

WO 02/29284 A1

# A linear actuator

The present invention relates to a linear actuator as stated in the preamble of claim 1.

5

Actuators of this type are for example known from EP 531 247 A1, EP 586 326 A1, EP 647 799 and EP 662 573 A1 all belonging to Linak A/S. The forces occurring on the spindle are absorbed by a push/pull bearing encapsulated  
10 in a plastic housing. The forces occurring between the bearing and the rear mounting are transferred through the plastic housing and the housing shall therefor be dimensioned and designed accordingly. Such a plastic housing constitutes a considerable amount of the  
15 actuators price. From WO 98/30816 Linak A/S there is known an example of a sophisticated actuator with a very high performance, where the forces between the bearing and the rear mounting are transferred via a metal chassis. These actuators are amongst others used built-in  
20 in furniture, for example in hospital and care beds, where is a requirement that the actuators are damp and waterproof. As an example there can be referred to EP 488 552 A1 Huntleigh Technology plc. As the actuators are completely or partly visible, it is additionally a  
25 requirement that the actuators have a minimum of design with smooth and dirt resistant surfaces.

A designless heavy duty actuator without a housing for industrial purposes is based on a supporting metal  
30 housing with integrated rear mounting, where the forces are transferred through this.

An actuator of this type is known from DE GM 94 04 383.3 U1, where the housing, which is of pressure die cast  
35 zinc, is formed with a cylindrical portion for the motor,

said cylindrical part can be closed with a cover. In addition the actuator is waterproof, with suitable sealing, such that it can be used for beds within the hospital and care sector. The pressure die cast zinc housing, which must be relatively large, as it has to include the motor, makes it a relatively expensive solution.

From EP 0 831 250 A2 is known an actuator with a housing. The housing includes a shell, which surrounds the motor and gearing. The shell, which is open to the rear that is towards the rear mounting of the actuator, is closed with a cover. To the front that is to towards the spindle, the shell is shaped with a fixing for the outer tube, said outer tube acting as a guide for the spindle nut and as a guide for the outer end of the spindle. The transversal forces, which in any case occur on the spindle, are transferred via the outer tube to the housing. It is accordingly stated that the housing and the outer tube are made of a rigid material and as an example are amongst others specified aluminum, zinc alloys and stainless steel, that is to say the specified plastic material, glass fibers containing nylon, polyvinyl chloride and polyethylene have an equivalent rigidity. On the whole a relatively expensive solution.

The purpose of the invention is to provide an actuator of the type first mentioned, which is cheap to produce, but in terms of performance and quality is equal to these.

According to the invention this is achieved by designing the actuator such that the console on the motor housing has an additional fixing for the outer tube, spindle bearing and the rear mounting, and designed to absorb the forces occurring hereon. The console can be designed only

with regard to transferring the forces between the bearing and the rear mounting and otherwise made so compact as possible. Accordingly, the motor housing and the console are the supporting parts of the actuator, in other words the chassis. As there are no special demands to the strength of the housing one is freer with regard to the production and the shape of the housing. Therefore the material thickness can be thin, and strengthening ribs can generally be completely avoided which means simpler moulding tools and easier production. Additionally, plastic types of a lower strength can be chosen which is in itself cheaper, but also a production advantage.

The known actuators are typically assembled with screws, which necessitates the moulding of screw wells and screw towers in the housing and the actual assembly is made manually. As the housing according to the invention is not part of the supporting structure this allows the possibility for the use of other not force transferring methods of assembly. According to an embodiment of the invention the housing is assembled by welding, preferably by ultrasonic welding. This is done by machine, reducing the manual assembly. Additionally, a complete welding makes the housing damp and waterproof, thereby avoiding a labyrinth sealing as with the known actuators. The joining edges can therefore be made more simply and at the same time a manual fitting of a seal is avoided.

The housing of the known actuators is two-pieced on a plane determined by the longitudinal axis of the spindle and parallel with the motor axle.

In contrast, according to the invention the housing is two-pieced on a plane determined by the longitudinal axis

of the spindle and at a right angle to the motor axle, or generally in this position. This gives assembly advantages, especially when the housing in addition is shaped with a cylindrical section for receiving the motor in an enclosing manner. In this manner the motor is utilized for fixing the housing, preferably with a sound/vibration absorbing layer in between. The housing can additionally be fixed so that it encloses and lies up against the outer tube and rear mounting in the dividing line. Further, the housing can be equipped with internal flanges for additionally fixing of this on the console.

A particular simple fixing of the outer tube is achieved by an enclosing opening in the console for axial insertion of one end of the outer tube. The outer tube is thereby fixed in a sideways direction. An axial fixing can be achieved by at least one into an opening in the outer tube inwards projecting pin or cam, preferably shaped on the end of a spring-leg. In order to ease the insertion of the outer tube the pin(s) is for this purpose shaped on a clamp, which can be slid in over the section with the enclosing opening. For fixing the clamp, its outer ends and the section are equipped with corresponding snap locking clips. Accordingly the outer tube can without resistance be inserted in the opening and subsequently locked with the clamp.

In an embodiment of the actuator the rear mounting is a separate part of the housing and receives the bearing. This has assembly advantages at the same time as the distance between the bearing and the rear mounting becomes quite short. The transferring of forces between the bearing and the mounting becomes therefore almost direct. By forming the rear mounting in two parts with a

recess for receiving the bearing, this is directly fixed in the longitudinally direction.

It is desirable being able to adjust the angle of the rear mounting to the construction in which the actuator should to be built into. This can be done in different ways, e.g. with a polygon shaped cross section, spline connection etc. In a preferred embodiment the rear mounting is designed with a cylindrical section to be received in a corresponding cylindrical opening in the console, and that the rear mounting has at least one projecting flange to be fitted into an indentation in the console, such that the rear mounting can be turned according to wishes.

To fix the outer end of the actuation rod to the construction into which the actuator is to be built, the rod can be supplied with different fittings, such as an eye, fork fitting or similar. The eye can simply be made in the actuation rod and with a bearing surface constituted of a raised rim of the eye into the hollow of the actuation rod. The end of the tube shaped rod can then be closed with a plug.

The known actuators are normally furnished with a fixed cable one end of which via a damp or waterproof is lead in is introduced into the housing. That is to say that one in advance should know the desired length of the cable alternatively furnish the actuators with a standard cable length and then either shorten or extend the cable after demand. In such case it is advantageous to design the housing with a well, which is in connection with a socket inside the actuator. In this manner the actuator can be supplied with the desired length of cable, also the cable is easily exchanged. The plug on the end of the

cable can be furnished with an O-ring for damp and waterproof tightening against the side walls of the well.

In an embodiment of the actuator this can be equipped  
5 with a control box designed to be fitted in the angle  
between the section of the housing over the motor and the  
outer tube, and where the end of the control box, which  
faces the housing has a shape which corresponds to this  
and can be attached hereto by ribs on the housing being  
10 received in corresponding grooves on the control box and  
where the control box can be fixed to the outer tube with  
a clamp. Typically the control box contains the  
controlling electronics and a power supply based on a  
transformer, i.e. the box can be quite heavy. When this  
15 in spite of the actuators relatively weak housing,  
nevertheless is possible to fit the control box to the  
housing, this is due to that the motor supports the  
relevant sections of the housing and that the outer tube  
is embedded in the console.

20

The actuator can also be equipped with a quick release  
function e.g. of the type specified in EP 0 685 662. The  
quick release function is used e.g. in actuators for  
hospital beds, where the mattress bearing surface can be  
25 quickly lowered to the horizontal level.

An embodiment of the invention should in the following be  
described in more detail with reference to the enclosed  
drawings, which show:

30

Fig. 1, a perspective view of the actuator,

Fig. 2, a longitudinal section through the actuator along  
the line A-A,

35

Fig. 3, an exploded view of the actuators rear end,

Fig. 4, a perspective view of one part of the cabinet,

- Fig. 5, a perspective view of the other part of the cabinet,
- 5 Fig. 6, a cross section of the outer tubes fixing,
- Fig. 7, a perspective view of the front end of the outer tube,
- 10 Fig. 8, a perspective view of the end signal switches,
- Fig. 9, a longitudinal section through an embodiment part of the actuator equipped with a quick release function,
- 15 Fig. 10, a cross section through an embodiment in Fig.9,
- Fig. 11, the release for the quick release function, and
- 20 Fig. 12, a perspective view of the actuator equipped with a control box.

As shown in the drawing the main parts of the actuator are constituted by a two-piece housing 1, a motor 2, a worm gear 3, a spindle 4, a spindle nut 5, an activation rod 6, an outer tube 7 and a rear mounting 8.

The motor is a reversible electric motor, typically a 24V or 48V DC-motor. The motor has a front cover 9, onto which a console 10 is fitted. The motor axle has an extended part formed as a worm 11, the free end of which is bedded in a journal bearing 12 molded in the console.

At the rear end of the spindle 4, a worm wheel 13 is fitted engaging the worm 11. The worm wheel 13 has on one side a cylindrical element 14 onto which a coil spring rests 15 to increase the self locking ability of the spindle, cf. EP 0 662 573 Linak. Hereafter comes a ball bearing 16 which is held in place shaping the end of the spindle as a rivet head.



The ball bearing 16 is encapsulated in a recess 17 in the rear mounting 8 consisting of two halves 8a, 8b. The rear mounting 8 has an eye 18, alternatively a fork fitting, to fix the actuator in the construction, into which it shall be built. One end of the coil spring is bent radially outwards and is held in a metal insert 19, which again is fixed in a recess in 20a, 20b in the dividing line between the two halves of the rear mounting 8a, 8b.

10 The rear mounting has a circular part 21, by means of which it is encased in a tube shaped section 22 in the console. The circular part 21 has four bosses 23, which fit into corresponding caves 24 in the wall of the console. The rear mounting can therefore be turned  
15 depending on, whether the eye 18 should turn one way or the other.

At the end of the console there is an exterior collar 25, and on the bosses 23, there are a radially extending legs  
20 23a such that there is a gap 26 between the collar and the legs. When the housing 1 is assembled the rear mounting 8 is fixed by that an internal flange 27 grips into the gap 26 and by doing so locks the rear mounting in the longitudinal direction. The rear mounting is  
25 additionally held in place by the end of the cabinet lying against a side wall 28 in a ledge on the rear mounting. On the ledge there is a groove 29, in which, for sealing purposes, an O-ring 30 is placed. When assembled the edge of the aperture in the cabinet seals  
30 against the O-ring.

The activation rod 6 consists of a tube fixed with the rear end to the spindle nut 5 with a fine pitch thread. Hereby the activation rod can be additionally fine  
35 adjusted, for optimal placement of the eye in relation to

the construction. The front end of the rod is closed with a close fitting plastic plug 31. The rod is fixed by means of an eye 32 to the construction, into which the actuator is to be built. The eye has a bearing surface 33 in the form of the rim of the hole has been raised inside the hollow of the rod.

The outer tube 7 consists of an extruded aluminum tube with a none circular cross section. In the outer end of the tube an end cover 34 is inserted having a circular hole for the actuation rod 6. The rear end of the outer tube is enclosed in a close fitting section 35 in the front end of the console. At the front, the section has an external collar 36 and at the rear a step 37. The outer tube has a flat upper side 38 and the enclosing section a corresponding lengthwise aperture 39.

A clamp 40 can be pushed onto the section 35, said clamp lying over the opening, while its legs grips around the sides of the section. The clamp is held in place in the longitudinal direction between the collar 36 and the side of the step 37. The clamp locks with snap lock means, namely by an internal protruding edge 41 on the lower end of its legs co-operating with an inwards edge 42 on the sidewall of the section 35. On the top of the clamp there are two taps 43, which, when the clamp is pushed in place are introduced into corresponding holes 44 on the upper side of the outer tube 38. The clamp locks the enclosing section, such that the outer tube is fixed both in the sideways and the longitudinal direction. The fixing positions at the same time the outer tube in the lengthwise direction.

On the inside of the outer tube there are four grooves 45 for preventing the spindle nut 5 against rotation, as the

nut has four corresponding external cams 46 on a collar, which fits into the grooves. In the tube there are two further grooves 47 positioned opposite each other for insertion of an elongated print-board 48, which has a  
5 signal switch 49 at each end, which are activated by a spring arm 50 fitted on a seat in connection with the switch. When the spindle nut reaches an end position, it will press the spring arm against the switch, which is then activated and via the control stops the motor. For  
10 this purpose the nut is having two opposite facing bevelled surfaces 59. In the rear end of the outer tube there is a plug 51 with edges, which fit into the grooves in the outer tube and the plug ends in a circular flange 52, which rests against the end of the tube. On this  
15 flange there is a radially extending tap 53, which fits into a corresponding notch at the end of the print board 48, and thereby fixing this in the longitudinal direction. Thereby are the end positions of the actuator determined.

20

It should be noticed that the forward face of the worm wheel 13 has a tube shaped portion 54, which is seated in a hole in the end plug 51. This supports to stabilize the axes of the worm wheel and also the end of the spindle.

25

With regard to sealing an O-ring 55 is placed around the outer tube. The O-ring lies in a groove defined by an edge in an aperture in the housing for the outer tube, the upper side of this and the outer side of the collar  
30 36 on the console.

The assembly of the actuator takes place as described or mainly as described in the previous. The last step is the assembly of the housing, which consists of two parts 1a,  
35 1b, divided on a plane through the axis of the spindle

and at an right angle to the motor axle. The part 1a has a cup shaped section to receive the motor and a bowl shaped section to receive one of the halves of the console. There are also four upright pins, holding a small print board 55 with a male plug 56. From the print board supply leads runs to the motor and connections for the signal leads from the end signal switches. In the other part of the housing 1b, which is bowl shaped, and contains the other section of the console, there is a well 57, which leads to the male connection. The well is designed to receive a female connector fitted with a sealing ring. For strain reliefs of the connection cable this is lead through a clamp 58 designed for this purpose and located on the cabinet part 1b.

15

An embodiment of the actuator having a quick release function is described in the following with reference to Fig. 9 and 10 in the drawing.

20 The quick release function comprises two clutch parts 70, 71, where one part 70 is fitted permanently to the spindle, whilst the other part 71 is fixed to the worm wheel 13 of the worm gear. More precisely the side of the worm wheel facing the front end of the actuator is constructed with a cylindrical section, upon which a bushing with a corbie-step is fixed. The clutch part 70 on the spindle is constructed with a bowl, which sits over this corbie-step. Around the two parts 70,71 a clutch spring 72 is fitted, which lies between the side of the worm wheel and a collar on the clutch part 71. During normal operation the spring 72 couples the two clutch parts 70,71 together, such that the spindle 4 via the worm gear is connected to the motor 2.

Around the clutch spring 72 there are two cylindrical elements 73,74 designed with an exterior toothing. The ends 72 of the clutch spring are bent radially outwards and are embedded in separated elements, that is in notches 82, 83 cp. Fig. 11. Notch 82 leads into element 74.

A Y-formed release 75 rides with its legs over the two cylindrical elements 73,74 such that one leg is opposite to one element, whilst the other leg 76 is opposite the other element 74. The upper stretch of the legs are smooth, whilst a lower stretch is having a toothing to fit the toothing on the elements 73,74.

The neck 77 of the Y-formed release 75 is controlled in a sleeve 78 fixed to the housing. On the neck there is a spring 79, which tightens between a shoulder in the opening of the sleeve and the upper side of the release such that, the release is spring loaded in a parking position, where the lowest, toothed part of the legs are out of contact with the two cylindrical elements 73, 74. To the top end of the neck there is fixed a cable 80 connected to a operating handle not shown.

When the handle is pulled the release is pulled up as shown in Fig.10 until the lower part 81 of the legs contacts the respective cylindrical elements 73,74 which then is turned opposite each other. The ends of the spring will then be pulled from each other, one clockwise and the other counterclockwise. In this way the spring will expand, i.e. its internal diameter will increase and the two clutch parts 73,74 are then released. The spindle will then be released and can rotate freely. If the activation rod 6 is under load and if it is in an extended position, it will then be pushed inwards,

depending on the load being able to overcome self locking ability of the spindle. In Fig.10 the release is shown in its operative position, whilst in Fig.11 it is shown in its inactive position. That only one leg is shown on the release in Fig.10, is due to the cross section.

As shown in Fig.12, the actuator can be fitted with a control box 60 containing control electronics and power supply and 61 shows the mains cable. A long side of the control box is concave 62 to receive and enclose one side of the outer tube. An end 63 is also concave to receive and enclose one side of the cylindrical part of the housing, which contains the motor. On this side of the housing there are two parallel ribs 64 having an L-shaped cross section, which couples with corresponding grooves in the end of the housing. The control box is fitted by guiding the end of the box along the housing of the actuator, such that the ribs 64 connect with the grooves and along until the long side grips around the outer tube. Finally the control box is locked to the outer tube with an U-shaped clamp 65, which is guided sideways across the outer tube, and which with clasp-locks on the inner side of the legs 66 of the clamp couples with clasp locks on the over and underside of the control box. The ends of the legs are fitted into a recess designed for this (90) on the cabinets upper and under side. The cable 67 from the actuator is connected with one of the sockets 68 of the control box and other actuators and a handset can be connected to the other sockets.

30

According to the invention there is thus provided a linear actuator which gives the possibility for lower production costs and at the same time the actuator can maintain a high quality, strength and flexibility with regard to accessories and fittings (front and rear mountings).

## Patent Claims:

1. A linear aktuator consisting of a housing (1),  
consisting of at least two parts (1a,1b), a reversible  
5 electric motor (2) with a motor axle and a motor housing,  
a worm drive with a worm wheel (13) and a worm (11),  
where the worm is constructed in or as a extension of a  
motor axle, a console (10) on the motor housing with a  
bearing (12) for seating of a free end of the worm, a  
10 spindle (4) connected with the worm wheel (13), a bearing  
(16) for bedding of the spindle (4), a spindle nut (5)  
fixed against rotation on the spindle, an outer tube (7)  
surrounding the spindle, an actuation rod (6),  
telescopically arranged in the outer tube and connected  
15 to the spindle nut, a fitting (33) on the outer end of  
the actuation rod, for mounting in the construction, in  
which the actuator is to be built-in, a rear mounting (8)  
at the other end of the actuator, opposite the actuation  
rod for mounting in the construction, in which the  
20 actuator is to be built-in, an electrical connection to  
the electric motor, c h a r a c t e r i z e d in that  
the console (10) on the motor housing further has a  
fixing for the outer tube (7), the spindle bearing (16)  
and for the rear mounting (8), and which is constructed  
25 to be able to absorb the forces occurring heron.

2. Actuator according to claim 1, c h a r a c t e r i z e  
d in that the housing being in two parts (1a, 1b) having  
a dividing plane defined by the longitudinal axis of the  
30 spindle(4) and at an right angle to the motor axle, or in  
essential such a plane.

3. Actuator according to claim 1, or 2, c h a r a c t e r  
i z e d in that the housing (1) comprises a cylindrical  
35 section receiving the motor (2) in an encasing manner.

4. Actuator according to one of the claims 1-3, characterized in that the housing (1) being assembled by welding, preferably ultrasonic welding.

5

5. Actuator according to claim 1, characterized in that by the console (10) having an opening (35) for receiving the outer tube (7) in an encasing manner.

10

6. Actuator according to claim 5, characterized in that the outer tube (7) being fixed longitudinally by at least one in an opening (44) in the outer tube (7) inwards protruding tap (43).

15

7. Actuator according to claim 6, characterized in that the tap (s) (43) are designed in a clamp (40), which rides over the section (35) with the encasing opening and that the clamp and the section have corresponding snap locks (41,42).

20

8. Actuator according to claim 1, characterized in that the rear mounting (8) is formed as a separate part of the console and receiving the bearing (16).

25

9. Actuator according to claim 8, characterized in that, the rear mounting being in two parts (8a,8b) with a recess (17) to receive the bearing.

30

10. Actuator according to claim 8 or 9, characterized in that by, the rear mounting (8) having a cylindrical section (21) to be received in a corresponding cylindrical opening (22) in the console and that the rear mounting has at least one flange (23) for fitting in a notch (24) in the console, such that the



rear mounting can be turned according to the actual wishes.

11. Actuator according to claim 1, characterized in that in the free end of the actuation rod (6) there is an eye (32) having a bearing surface (33) consisting of the eye having a raised rim in the hollow of the rod.

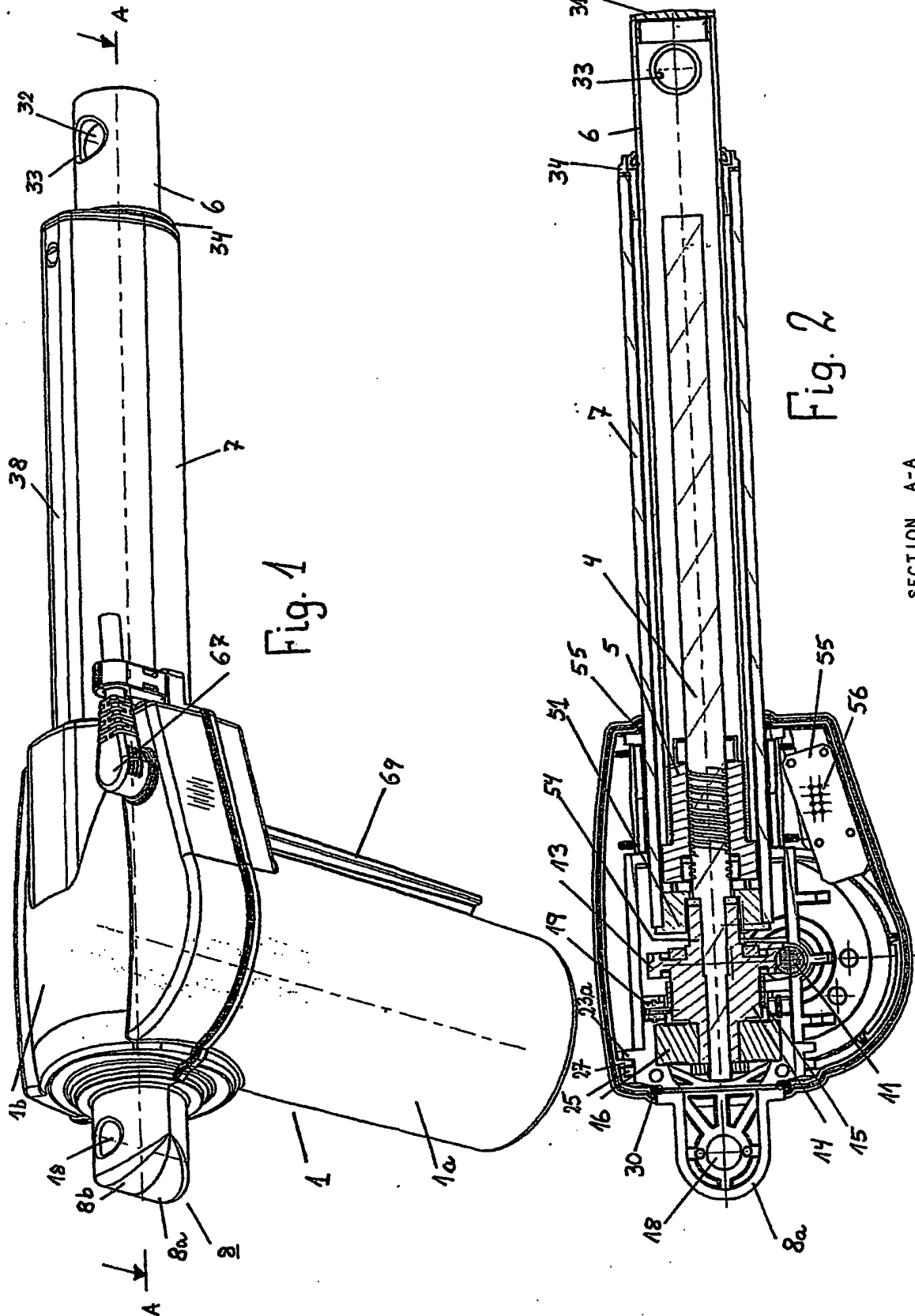
12. Actuator according to claim 1, characterized in that by a well being formed in the housing (57), in connection with a socket (56) inside the actuator.

13. Actuator according to claim 1, characterized in having a quick release comprising two cylindrical clutch parts (70,71) surrounded by a clutch spring (72) having outward bent ends, said ends being connected with its respective cylindrical element (73,74), seated to under normal circumstances, to take part in the rotation of the clutch, and where the two cylindrical elements (73,74) with a release (75) are fitted to enable them to impart a mutual rotation to turn the ends of the spring away from each other such that, the spring (72) is released from at least one of the clutch parts (70,71) for complete or partly release from the clutch, and where the two cylindrical elements (73, 74) are having an exterior toothing, and that the release (75) has a corresponding toothing, which can be brought to mesh and thereby to a mutual turning of the elements (73,74).

30

14. Actuator according to the claim 1, characterized in being equipped with a control box (60) designed for fixing in the angle between the housing part sitting over the motor (1a) and the outer tube (7), where the control box end (63), which faces the housing has a

shape corresponding to this and can be fixed hereto with ribs (69) on the cabinet, said ribs being received in corresponding grooves on the control box (60), and where the control box with a clamp (65) can be fixed to the  
5 outer tube (7).



SECTION A-A

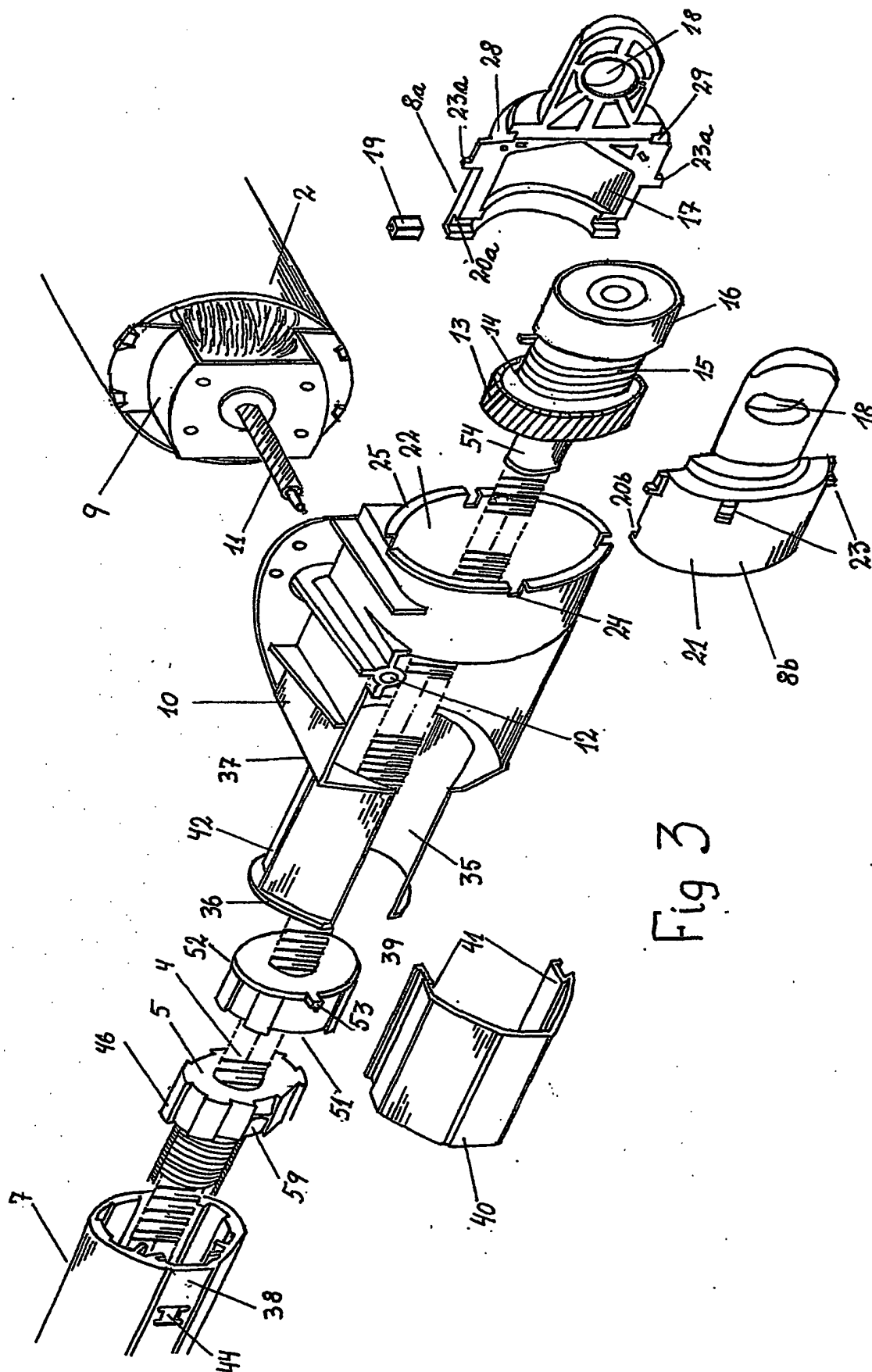


Fig 3

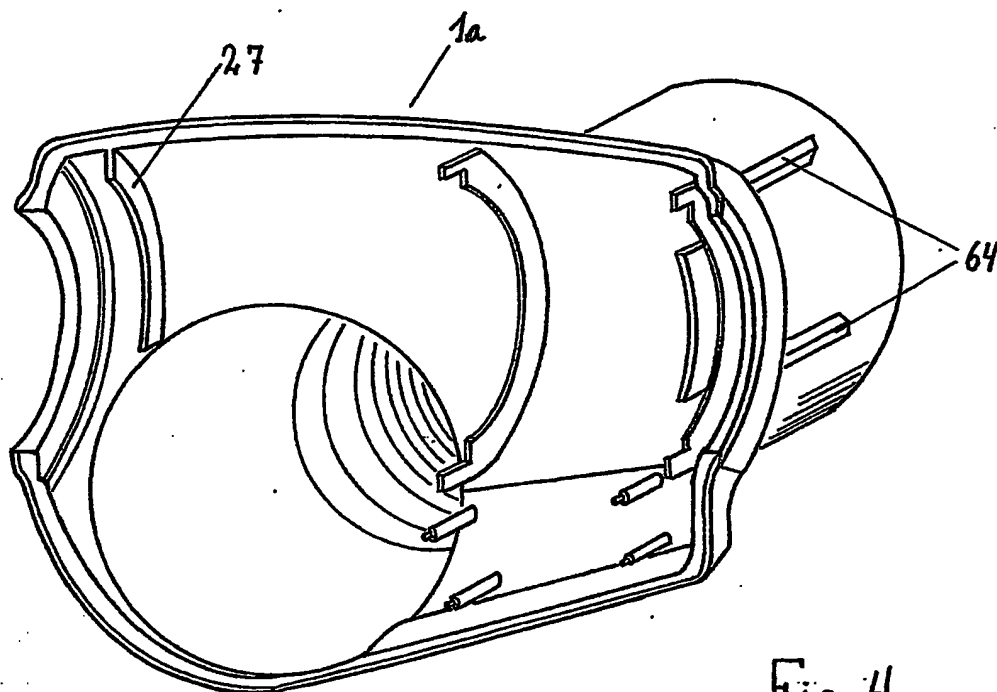


Fig. 4

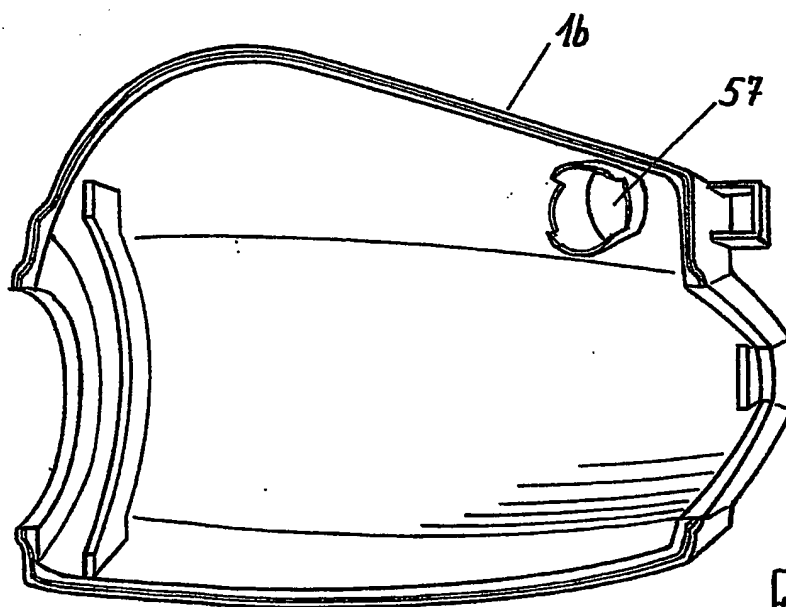


Fig. 5

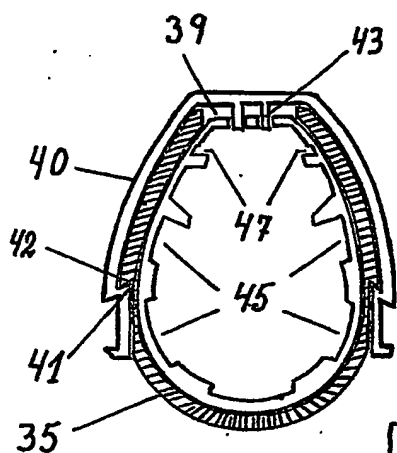


Fig. 6

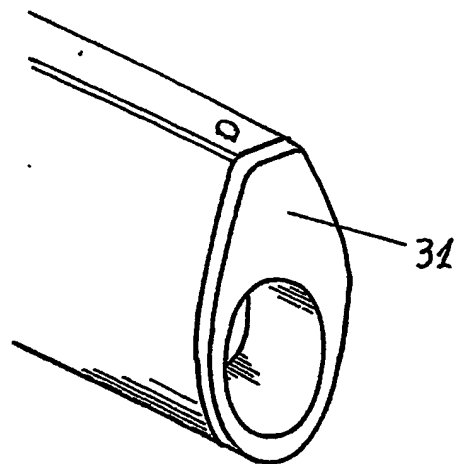


Fig. 7

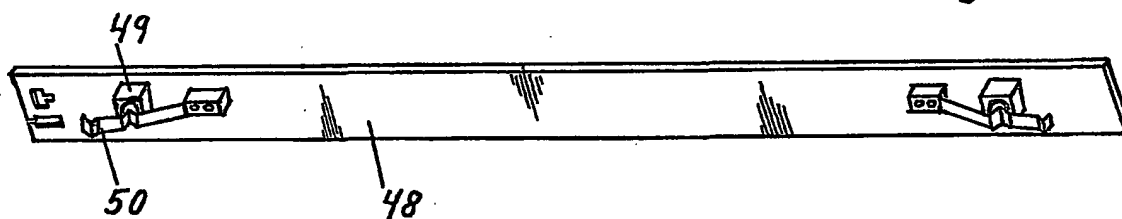


Fig. 8

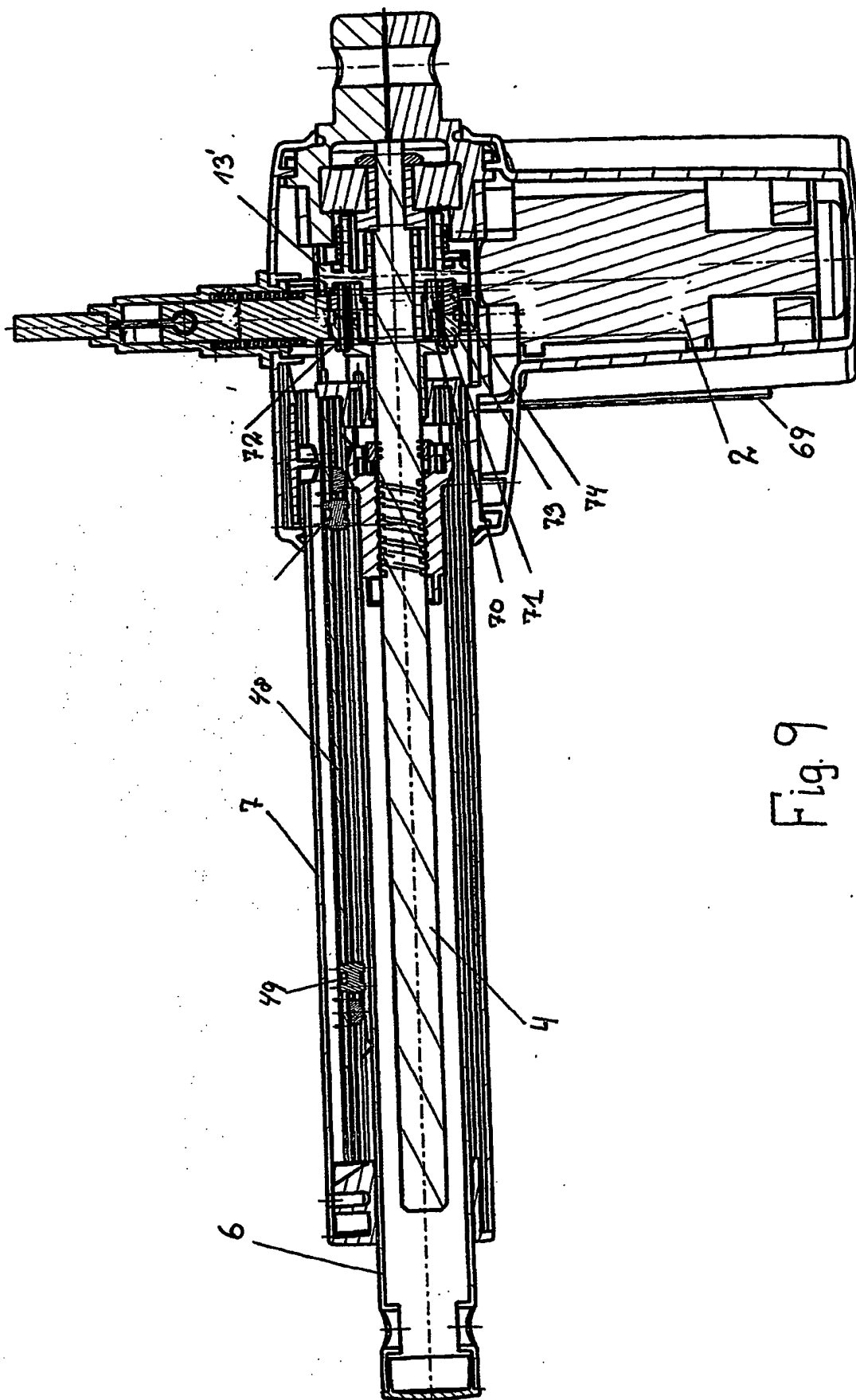
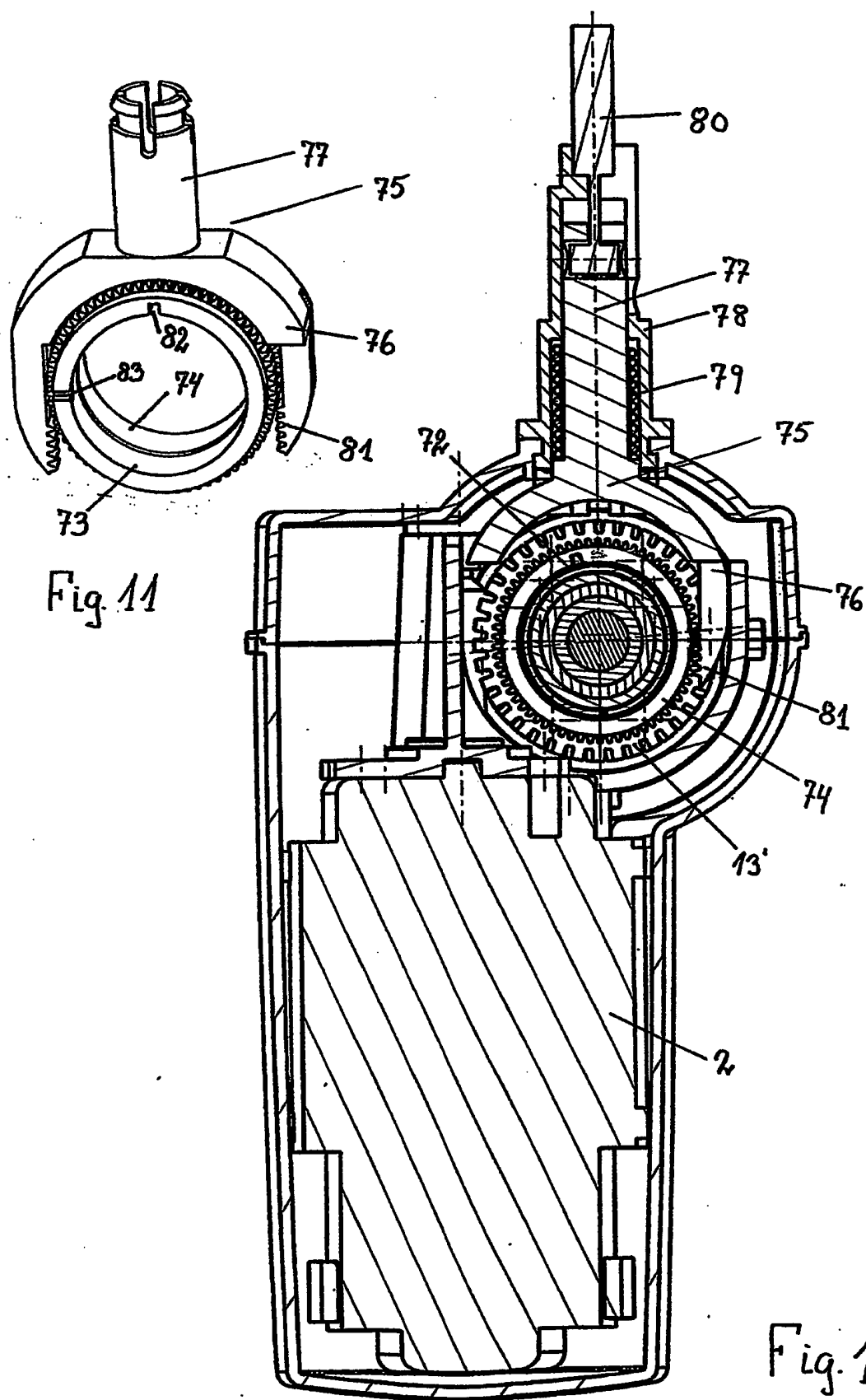


Fig. 9





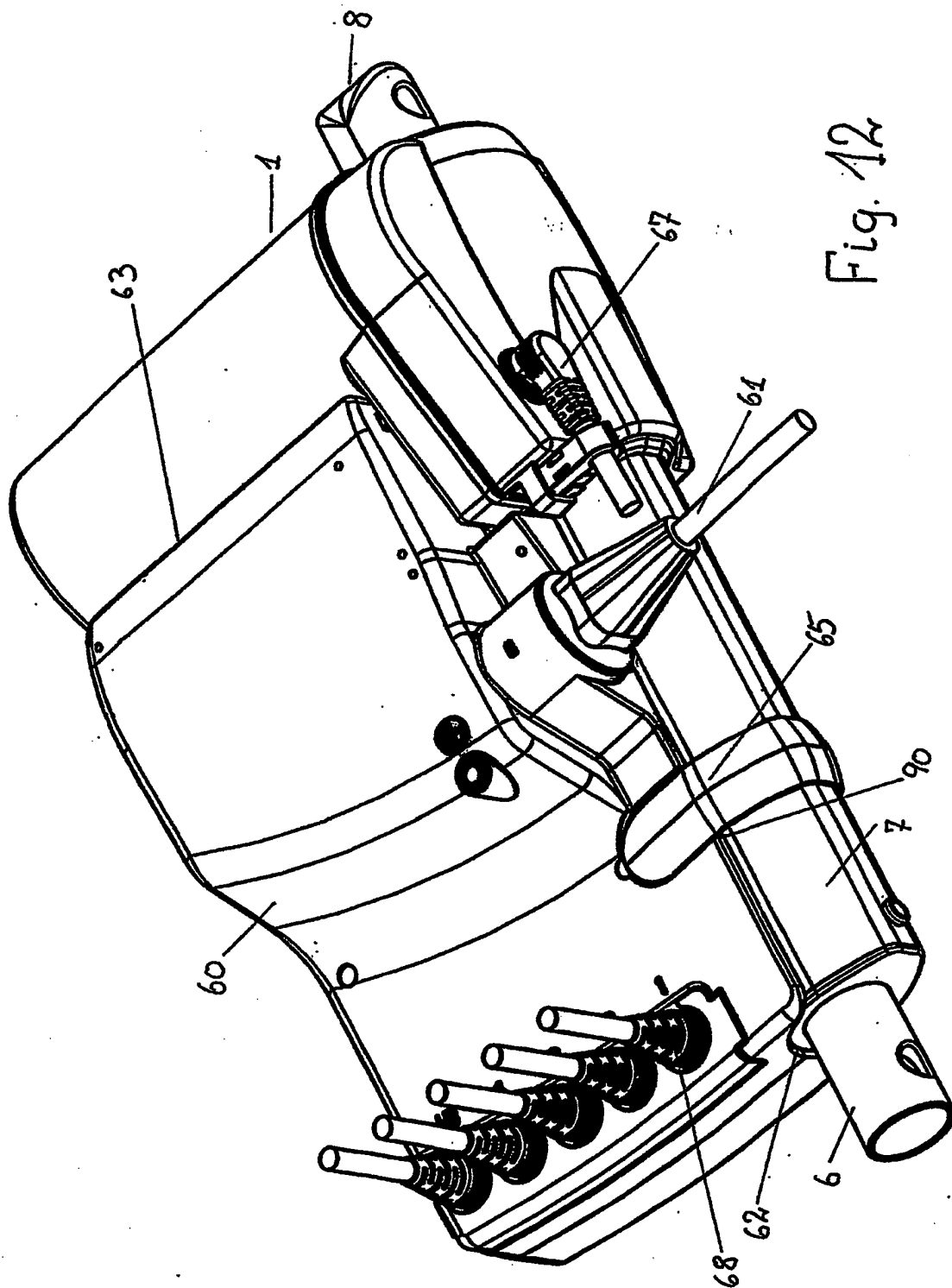


Fig. 12

## INTERNATIONAL SEARCH REPORT

International Application No.

PCT/DK 01/00644

## A. CLASSIFICATION OF SUBJECT MATTER

IPC7: F16H 25/20, H02K 7/06

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: F16H, H02K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5809833 A (NEWPORT ET AL), 22 Sept 1998 (22.09.98) --	1-14
A	US 4858481 A (ABRAHAM), 22 August 1989 (22.08.89) --	1-14
A	EP 0831250 A2 (DANA CORPORATION), 25 March 1998 (25.03.98) --	1-14
P,A	WO 0171218 A1 (DEWERT VERWALTUNGS GMBH), 27 Sept 2001 (27.09.01) -- -----	1-14

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&amp;" document member of the same patent family

Date of the actual completion of the international search

4 January 2002

Date of mailing of the international search report

21-01-2002

Name and mailing address of the ISA/

Swedish Patent Office

Box 5055, S-102 42 STOCKHOLM

Facsimile No. +46 8 666 02 86

Authorized officer

Per-Olof Warnbo / JA A

Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1998)

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

06/11/01

International Application No.  
PCT/DK 01/00644

Patent document cited in search report			Publication date	Patent family member(s)		Publication date
US	5809833	A	22/09/98	EP	0831250 A	25/03/98
US	4858481	A	22/08/89	US	4712441 A	15/12/87
				US	4889002 A	26/12/89
EP	0831250	A2	25/03/98	US	5809833 A	22/09/98
WO	0171218	A1	27/09/01	DE	20005065 U	25/05/00

Form PCT/ISA/210 (patent family annex) (July 1998)

**This Page is Inserted by IFW Indexing and Scanning  
Operations and is not part of the Official Record**

**BEST AVAILABLE IMAGES**

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ **BLACK BORDERS**
- ☐ **IMAGE CUT OFF AT TOP, BOTTOM OR SIDES**
- ☐ **FADED TEXT OR DRAWING**
- ☐ **BLURRED OR ILLEGIBLE TEXT OR DRAWING**
- ☐ **SKEWED/SLANTED IMAGES**
- ☐ **COLOR OR BLACK AND WHITE PHOTOGRAPHS**
- ☐ **GRAY SCALE DOCUMENTS**
- ☒ **LINES OR MARKS ON ORIGINAL DOCUMENT**
- ☐ **REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY**
- ☐ **OTHER:** \_\_\_\_\_

**IMAGES ARE BEST AVAILABLE COPY.**

**As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.**